NASA/Tropical Rainfall Measuring Mission (TRMM)
Topic #5: Rain
Teacher's Guide
Grades 6 - 9

Overview: This topic introduces students to concepts related the remote sensing of precipitation**. Activity #1/Narrative** describes conditions that lead to the development of rain, and includes a brief explanation of how radar is used to detect its presence in clouds. **Activity #2/ Measuring the Size of "Raindrops"** introduces concepts related to verifying remotely sensed data, and provides a hands on investigation in which they measure drops, then convert their measurements into a backscatter value which is similar to the radar reflectivity values used to produce images. In **Activity #3/Interpretation of Satellite Images**, students view the cross section images produced by TRMM which reveal precipitation distribution within various storms.

National Science Education Content Standards: The activities provided in this topic meet Content Standards A,B,D,E,F and G. A comprehensive list of the Content Standards with relevant subtopics is located at the end of the *Teacher's Guide.*

Activity #1: Narrative on Rain

- **Objective**: To introduce concepts related to the formation of rain and explore the methods used by the TRMM satellite to measure tropical rainfall.
- **Type of Activity:** Students read a narrative summary with bold-faced vocabulary
- **What's Happening?:** The narrative explains the conditions which lead to the formation of precipitation and factors which affect drop size. The role of the TRMM satellite in measuring rainfall is discussed. The narrative concludes with a basic overview of how radar is used to measure precipitation.
- **Vocabulary:** Key words in the narrative are bold-faced and defined.
- **Figure:** A sample TRMM radar image is provided
- **Your Thoughts** Answers:

1. Describe the formation of a cloud.
   Warm, humid air rises, cools and condenses into cloud droplets.
2. What force limits the size of a falling raindrop?
   The upward resistance of air flattens drops larger than 6 mm and breaks them apart.
3. Why is it helpful to scientists to be able to measure rainfall from a satellite?
   Satellites enable them to measure rain in remote areas such as oceans.
4. How does the information provided by a radar profile give scientists a better understanding of rain?
   Profile data provides information on the intensity and distribution of rain within a cloud.

Activity #2: Lab/Measuring the Size of "Raindrops"

- **Objective:** To measure the size of water drops that represent "rainfall"
- **Type of Activity:** Students perform a hands on investigation in which they measure the size of drops on a powdered surface to model a process of attaining ground level data for verification of remote sensors. The drop measurements are used in math calculations that simulate the process of converting measurements into reflectivity values for use on images.
- **Background:** The process of remote sensing is briefly explained, and the need for checking satellite instrument values with ground level measurements is introduced.
- **Materials: (per group)** cornstarch, sifter or screened tea strainer, metric ruler, eye dropper, small container with water, waxed paper or plastic wrap, calculator, transparency pen, magnifying lens.
- **Procedure:** Steps #1 –8 Students use a transparency pen to mark a square on a piece of wax paper. Cornstarch is sifted over the square. An eyedropper is used to simulate drops of rain. A ruler and magnifying glass are use to measure the drop size. Math calculations are used to model the process of converting the measurements into backscatter and radar reflectivity values that are used to create images.
- **Questions – Answers:**

9. In what way could computers be used?
   Computers could be programmed to do the math calculations.
10. For what reason would they (scientists) go to locations in the satellite's path to measure the actual size of the raindrops?
    They would use the ground level data to verify the accuracy of the satellite data.

Activity #3: Interpretation of Satellite Images

- **Objective:** To interpret images produced by the Precipitation Radar that is one of the instruments aboard the TRMM satellite.
- **Type of Activity:** Students view NASA/TRMM satellite images of rainfall profiles and compare TRMM images to the images offered by Intellicast. The value of studying the distribution of rain as depicted by TRMM's profile images is noted.
- **Materials:** (per student) colored pencils (red, yellow, orange, light & dark green)
  Computer with Internet access to < http:// trmm.gsfc.nasa.gov/ >
  NOTE: If students do not have on line access, make the following images into transparencies or color copies:
  http://trmm.gsfc.nasa.gov/data/houston_inserts_md.html
  http:// trmm.gsfc.nasa.gov/data/nc3insertpr-sm.html
  http://www.intellicast.com/LocalWeather/World/United States/Precipitation/
  These images may also be accessed under the "Images" feature of this web site.
- **Procedure:** The *Procedure* and *Interpretation* section of the lesson list the steps required to access the web sites or documents used in this lesson. Students use these images to answer the following questions:

4. a. How would a geostationary satellite that is positioned over one area improve scientists' understanding of a particular storm?

The lifecycle of the entire storm could be studied as opposed to the window of information that is provided by a satellite passing over head.

b. Does the red/high intensity reach to the top of the cloud? **No**

Draw the image with a key

d. In the left image, what is the height of the three large clouds?

11 km, 10 km, 12 km

e. Describe the rain distribution of the red/ high intensity? **Vertical**

5. f. What color is used to indicate 3 to 4 inches of rain? **yellow**

g. What area of the map is showing the greatest rain intensity? **Answer dependent on rainfall on current image**

h. How do TRMM image differ from these images? **TRMM shows a path over a smaller area, but reveals a cross-section showing rainfall distribution with the cloud.**

i. Why does TRMM have a high orbital speed? **The high speed is needed to counteract the pull of the Earth's gravity.**

National Science Education Standards
The NASA/TRMM Activities support the following standards:
CONTENT STANDARDS; Grades 5-8

A. Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

B. Physical Science
- Properties and changes of properties in matter
- Transfer of energy

C. Life Science

D. Earth and Space Science
- Structure of the Earth

E. Science and Technology.
- Abilities of technological design
- Understandings about science and technology

F. Science in Personal and Social Perspectives
- Natural Hazards
- Science and technology in society

G. History and Nature of Science
- Science as a human endeavor
- Nature of science

CONTENT STANDARDS; Grades 9-12

A. Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

B. Physical Science
- Structure and properties of matter
- Interactions of energy and matter

C. Life Science

D. Earth and Space Science
- Structure of the Earth
- Geochemical cycles

E. Science and Technology.
- Abilities of technological design
- Understandings about science and technology

F. Science in Personal and Social Perspectives
- Natural and human-induced hazards
- Science and technology in local, national and global challenges

G. History and Nature of Science
- Science as a human endeavor
- Nature of scientific knowledge